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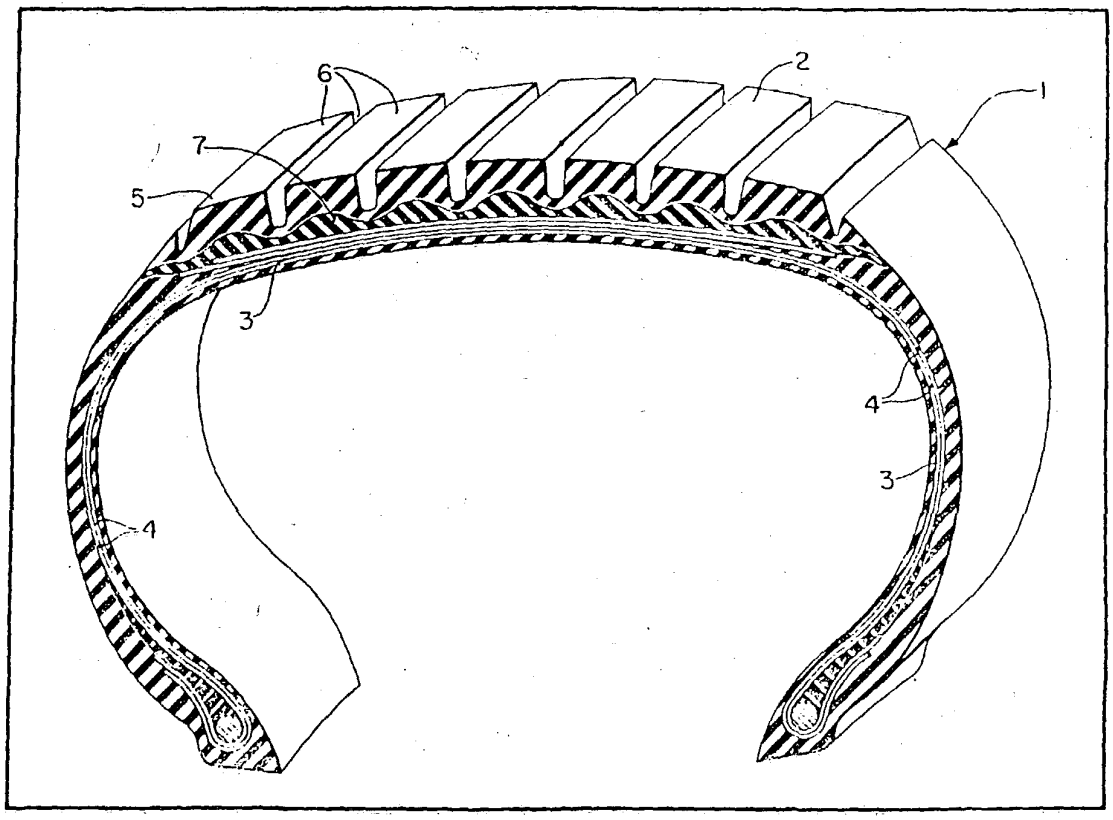
(71) Applicant The Goodyear Tire & Rubber Company, 1144 East Market Street, Akron, Ohio, United States of America
(72) Inventor David Allen Kindry
(74) Agent Carpmaels & Ransford, 43 Bloomsbury Square, London WC1A 2RA

(54) **Pneumatic Tire Tread**

(57) A pneumatic tire with a radial ply carcass has a tread composed of (1) an outer rubber cap composition 5 including a high reinforcing carbon black, e.g. HAF, ISAF or SAF, and having a hot rebound value (as measured by ASTM 1054-66) in the range of 55 to 70 and (2) a base rubber composition 7 including a semi-reinforcing carbon black, e.g. FEF, GPF or SRF, and having a hot rebound value in the range of 75 to 90. The cap composition 5 may include butadiene/styrene rubber together with polybutadiene and/or cis-1,4-polyisoprene, and the base composition 7 may comprise butadiene/styrene rubber, natural rubber and polybutadiene, specific formulations for the compositions being given in the specification.



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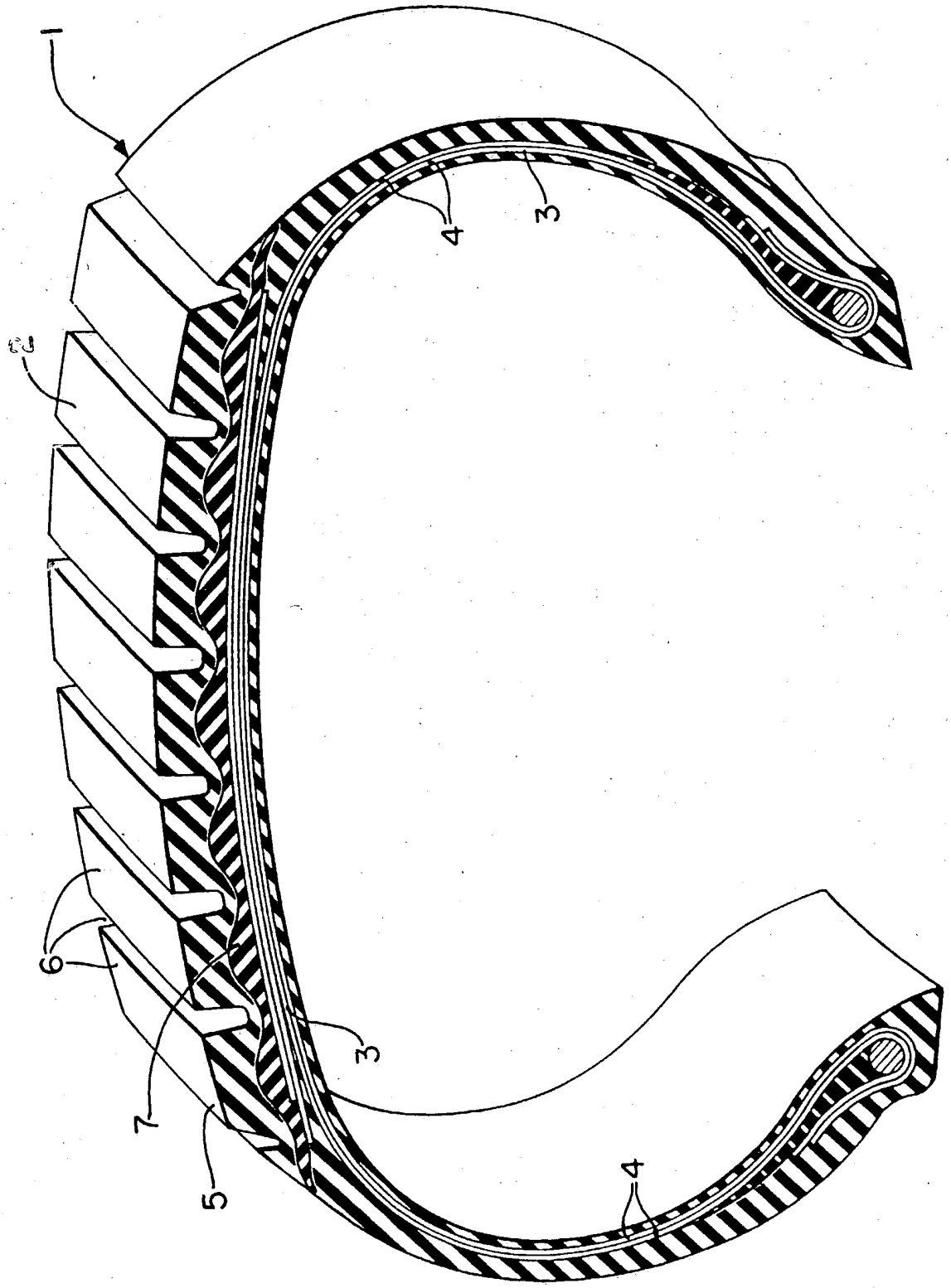
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SPECIFICATION

Pneumatic Tire Having Modified Tread

Field of Invention

This invention relates to pneumatic tires and particularly relates to pneumatic tires having a tread of a cap-base construction.

Background of the Invention

Pneumatic tires are generally constructed with the application of outer, extruded, homogeneous tread stock over a supporting carcass of a plurality of rubberized fabric plies. The tread extrusion is generally of a compounder rubber, sometimes referred to as a rubber compound, that, when cured, provides the tread of the tire with a high degree of resistance to tread wear during its use on a vehicle, preferably without promoting an excessive heat build-up in the tire itself. The excessive heat build-up would be detrimental to the durability of the tire, particularly its supporting carcass.

Alternately a rubber tread of a cap-base construction has been proposed (U.S. Patent 3,157,218). There the outer, ground contacting portion of the tread, or cap, was composed of a rubber designed to provide conventional resistance to tread wear, good traction ability. The outer cap portion of the tread was adhered to an inner tread portion, or base, disposed between the cap and the supporting carcass. The base rubber composition was compounded with the intention of diminishing heat build up in the overall tread. The patent disclosure achieved its cap-base construction purpose by utilizing a substantial amount of polybutadiene rubber in both the cap and the base. It should be pointed out that its disclosure primarily related to the reduction of tire failures such as rib tear and groove cracking, in truck tires of the bias ply type construction, particularly since radial construction tires were not widely used at that time.

However, methods of reducing rolling resistance of a tire to effect an energy savings while maintaining adequate traction yet keeping heat build-up to acceptable limits are still sought after.

Disclosure and Practice of the Invention

In accordance with this invention, a pneumatic rubber tire is provided with a radial ply carcass having a tread across its crown composed of (A) an outer rubber cap composition of, based on 100 parts by weight rubber, (1) about 85 to about 100 weight percent butadiene/styrene rubber and, correspondingly, about zero to 15 weight percent polybutadiene, (2) about 50 to about 100 weight percent butadiene/styrene rubber and, correspondingly, about 0 to about 50 weight percent cis 1,4-polyisoprene or (3) about 50 to 80 weight percent butadiene/styrene rubber, about 10 to 40 weight percent polybutadiene and about 10 to 40 weight percent cis 1,4-polyisoprene; said rubber reinforced by containing about 50 to 100 phr of a high reinforcing carbon black and characterized by having a hot rebound value in the range of about 55 to about 70, according to ASTM 1054—66 and (B) a base composition disposed between said outer cap and said carcass of the tire as an adherent interlayer comprised of a rubber composition of, based on 100 parts by weight rubber, (1) about zero to 30 weight percent butadiene/styrene rubber, (2) about 20 to about 50 weight percent natural rubber, and (3) about 40 to about 70 weight percent polybutadiene; said rubber mixture reinforced by containing about 30 to 70 phr semi-reinforcing carbon black characterized by having a hot rebound value in the range of about 75 to about 90 according to ASTM 1054—66.

The cap-base design was used to decrease heat generation or heat build-up in a tread which had been compounded for improved, or reduced, rolling resistance. It is generally understood that changing a tread compound to reduce its rolling resistance will also generally result in a loss of traction and a decrease in heat build-up. The cap-base concept of this invention is designed to allow a reduction in rolling resistance without an appreciable or substantial loss in traction nor increase in heat build-up.

Reference to the drawing shows a radial tire 1 with a tread 2 adhered to a supporting carcass 3 composed of a plurality of rubberized fabric plies 4. The tread 2 is composed of an outer cap 5 which contains the lugs and groove matrix 6 adhered to the inner base 7.

The thickness of the cap 5 and the base 7 portions of the tread 2 construction can vary over a reasonably considerable range. However, in general, for the green and uncured tire the base portion should be at least about 40 mils in thickness, and preferably in the range of about 40 to about 120 mils. Upon shaping and curing the tire in the mold, the previously extruded rubber tread flows into the face of the tread contour of the mold and the interface between the base and the tread assumes a somewhat undulating shape 8. In this manner, the base tends to be thicker in the lug configuration of the tread 9 and thinner in the groove configuration of the tread 10. In this final condition the cap portion of the tread should be sufficiently thick to provide at least about 20 mils of rubber thickness below the bottom of the groove portion of the tread and preferably a thickness in the range of about 20 to about 100, more preferably about 50 to about 100 mils in this area. Clearly it is desired that the base does not extend to the outer wearing surface of the tread lug because it would be considerably faster wearing than the cap composition. However, if the tire is of a very good wearing quality or, in other words, exhibits good tread wear characteristics, then in some cases the base could strike through a portion of the wearing surface and still provide a tire with overall good wearing characteristics.

In the description of this invention, it has been pointed out that different types of carbon black are to be used for the cap as compared to the base portions of the tread.

Representative of the high reinforcing blacks utilized for the outer cap portion of the tread are those having various ASTM designations such as N110, otherwise sometimes known as Super Abrasion Furnace Black (SAF), N220, sometimes otherwise known as Intermediate Super Abrasion Furnace Black (ISAF), and N330, sometimes otherwise known as High Abrasion Furnace Black (HAF).

The semi-reinforcing carbon blacks utilized for the base portion of the tread have ASTM designations such as N660, sometimes otherwise known as General Purpose Furnace Black (GPF), N762, sometimes otherwise known as Semi-Reinforcing Furnace Blacks (SRF) and N550, sometimes otherwise known as Fine Extrusion Furnace Black (FEF).

The practice of this invention is further illustrated by reference to the following examples which are intended to be representative rather than restrictive of the scope of the invention. Unless otherwise indicated, all parts and percentages are by weight.

Example 1

Rubber compositions were formulated to prepare the cap and base portions of an extruded tread stock, according to the following general recipe shown in Table 1.

Table 1
Components

Tread Cap Formulation		*Tread Base Formulation*	
Polybutadiene (oil extended)	12.50	Natural Rubber	40.00
Butadiene/styrene rubber (oil extended)	123.75	Polybutadiene	60.00
Carbon black (ISAF)	80	(FEF)	50
Waxes	4.00	Waxes	1.00
Processing oil	12.00	Processing oil	15.00
Antioxidant	2.00	Antioxidant	3.00
Accelerator	1.00	Accelerator	0.50
Zinc oxide	3.00	Zinc oxide	3.00
Sulfur	1.50	Sulfur	2.25

The formulations of Table 1 were mixed separately, extruded together, co-extruded in one piece, and applied to a radial ply rubber tire carcass as a cap-base tread and accompanying sidewalls having the same formulation as the base. The tire was then molded through shaping and curing under pressure to form the resulting pneumatic vehicle tire (size GR 78-15).

Samples of the cured cap composition of the tread were analyzed and found to have a hot rebound value of about 62 according to ASTM 1054—66.

Portions of the cured base compound were tested and found to have a hot rebound value of about 78 according to ASTM 1054—66.

The pneumatic tire was mounted on a rim, inflated and driven by 67.2 inch (271 cm) diameter fly wheel for the purpose of evaluating its rolling resistance. The rolling resistance factor was tested by adjusting fly wheel torque and measuring the torque by transducer in the drive line or fly wheel. The test tire's rolling resistance was compared to that of a control tire utilizing a tread compound increasing to the experimental tire's cap formulation. In this test, the experimental tire had about 5% less rolling resistance than the control tire.

In Table 2 the results of various test values are shown, particularly the hot rebound values, rolling resistance and wet and dry traction. It is important to appreciate that Table 2 shows that the enhanced rolling resistance of the cap/base tire was achieved without sacrificing the wet and dry traction factors.

Table 2

Physical Test Value	*Cap Base Tire*	*Control Tire*
1. Hot Rebound Value	Tread 62 Base 78	Tread 62
2. Rolling Resistance (pounds)[1,2]	105 (5% more efficient)	100
3. Wet traction[1]	100	100
4. Dry traction[1]	100	100

[1]Using a value determined for the control tire to be 100.

[2]As determined by testing the pneumatic tire in its inflated state as mounted on a rigid, centered, rim under about a 80% of rated load against a 67.23 inch diameter fly wheel as measured in pounds.

While certain representative embodiments and details have been shown for the purpose of

illustrating the invention, it will be apparent to those skilled in this art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

Claims

1. A pneumatic rubber tire with a radial ply carcass characterized by having across its crown, a cured rubber tread composed of (A) an outer rubber cap composition of, based on 100 parts by weight rubber, (1) about 85 to about 100 weight percent butadiene/styrene rubber and, correspondingly, about zero to 15 weight percent polybutadiene, (2) about 50 to about 100 weight percent butadiene/styrene rubber and, correspondingly, about 0 to about 50 weight percent cis 1,4-polyisoprene or (3) about 50 to 80 weight percent butadiene/styrene rubber about 10 to 40 weight percent polybutadiene and about 10 to 40 weight percent cis 1,4-polyisoprene; said rubber reinforced by containing about 50 to 100 phr of a high reinforcing carbon black and characterized by having a hot rebound value in the range of about 55 to about 70, according to ASTM 1054—66 and (B) a base composition disposed between said outer cap and said carcass of the tire as an adherent interlayer comprised of a rubber composition of, based on 100 parts by weight rubber, (1) about zero to 30 weight percent butadiene/styrene rubber, (2) about 20 to about 50 weight percent natural rubber and (3) about 40 to about 70 weight percent polybutadiene; said rubber mixture reinforced by containing about 30 to 70 phr semi-reinforcing carbon black characterized by having a hot rebound value in the range of about 75 to about 90 according to ASTM 1054—66.

2. The pneumatic rubber tire of claim 1 where said outer rubber cap of said tread is composed of, based on 100 parts by weight rubber, a rubber cap composition of (A) about 70 to about 100 weight percent butadiene/styrene rubber and, correspondingly, (B) about 0 to about 30 weight percent of at least one rubber selected from polybutadiene or natural rubber.

3. The pneumatic rubber tire of claim 2 where, in the green and uncured tire the base portion of said tread has a thickness in the range of about 40 to about 120 mils and, in the shaped and cured tires, the cap portion of said tread has a thickness of about 20 to about 100 mils of rubber below the bottom of the groove portion of the tread.

4. The pneumatic tire of claim 3 wherein the high reinforcing carbon black for the outer rubber cap composition is selected from at least one of SAF, ISAF or HAR carbon black and the semi-reinforcing carbon blacks for said base composition are selected from at least one of GPF, SRF or FEF carbon black.

5. A pneumatic tire as claimed in claim 1, substantially as described in the foregoing Example.

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